3.1 Hardware – Computer Architecture
QUESTIONS

3 - Hardware

3.1 Computer architecture				
1	(a) Understand the role of the central processing unit (CPU) in a computer			
1	(b) Understand what is meant by a microprocessor			
2	(a) Understand the purpose of the components in a CPU, in a computer that has a Von Neumann architecture			
2	(b) Describe the process of the fetch–decode–execute cycle including the role of each component in the process			
3	Understand what is meant by a core, cache and clock in a CPU and explain how they can affect the performance of a CPU			
4	Understand the purpose and use of an instruction set for a CPU			
5	Describe the purpose and characteristics of an embedded system and identify devices in which they are commonly used			

More Guidance:

3.1 Computer architecture

Candidates should be able to:	Notes and guidance
1 (a) Understand the role of the central processing unit (CPU) in a computer	• The CPU processes instructions and data that are input into the computer so that the result can be output
(b) Understand what is meant by a microprocessor	• A microprocessor is a type of integrated circuit on a single chip
2 (a) Understand the purpose of the components in a CPU, in a computer that has a Von Neumann architecture	• Including: – units: arithmetic logic unit (ALU) and control unit (CU) – registers: program counter (PC), memory address register (MAR), memory data register (MDR), current instruction register (CIR) and accumulator (ACC) – buses: address bus, data bus and control bus
(b) Describe the process of the fetch–decode–execute cycle including the role of each component in the process	• How instructions and data are fetched from random access memory (RAM) into the CPU, how they are processed using each component and how they are then executed • Storing data and addresses into specific registers • Using buses to transmit data, addresses and signals • Using units to fetch, decode and execute data and instructions
3 Understand what is meant by a core, cache and clock in a CPU and explain how they can affect the performance of a CPU	• The number of cores, size of the cache and speed of the clock can affect the performance of a CPU
4 Understand the purpose and use of an instruction set for a CPU	• An instruction set is a list of all the commands that can be processed by a CPU and the commands are machine code
5 Describe the purpose and characteristics of an embedded system and identify devices in which they are commonly used	• An embedded system is used to perform a dedicated function, e.g. domestic appliances, cars, security systems, lighting systems or vending machines. This is different to a general purpose computer that is used to perform many different functions, e.g. a personal computer (PC) or a laptop

3.1 Hardware – Computer Architecture
QUESTIONS

1 A student uses a computer and several hardware devices to complete his schoolwork.

The computer has a central processing unit (CPU).

(a) The student uses a keyboard to complete his schoolwork.

Tick (✓) **one** box to show which type of device the keyboard is.

A input ☐

B memory ☐

C output ☐

D storage ☐

[1]

(b) The student uses a printer to print his schoolwork.

Tick (✓) **one** box to show which type of device the printer is.

A input ☐

B memory ☐

C output ☐

D storage ☐

[1]

(c) A component in the CPU sends signals to manage the fetch-decode-execute cycle.

State the name of this component.

..... [1]

(d) The CPU has a clock speed of 2.4 Ghz.

Describe what is meant by a 2.4 Ghz clock speed.

.....

.....

.....

..... [2]

(e) The CPU contains registers including the memory data register (MDR).

(i) Describe the role of the MDR in the fetch-decode-execute cycle.

.....

.....

.....

..... [2]

(ii) Identify **three** other registers contained in the CPU.

1 .....

2 .....

3 .....

[3]

3 A user's computer has a central processing unit (CPU) that has a clock speed of 2 GHz.

She wants to change it to a CPU that has a clock speed of 3 GHz.

(a) (i) State what is meant by clock speed.

.....

..... [1]

(ii) Explain the effect this change will have on the performance of the CPU.

.....

.....

.....

..... [2]

(b) The CPU contains a memory address register (MAR).

Describe the role of the MAR in the fetch–decode–execute cycle.

.....

.....

.....

..... [2]

(c) The CPU has a list of all the machine code commands it can process.

State the name of this list of commands.

..... [1]

4 A washing machine is an example of an embedded system.

(a) Give **two** characteristics of an embedded system.

1 .....

.....

2 .....

.....

[2]

(b) Circle **three** other examples of an embedded system.

freezer laptop

personal computer (PC) security light system smartphone

vending machine web server

[3]

3 A computer has a central processing unit (CPU).

(a) Circle **three** components that are built into the CPU.

accumulator (ACC) control unit (CU) graphics card

hard disk drive (HDD) motherboard program counter (PC)

random access memory (RAM) read only memory (ROM)

[3]

(b) The CPU has cache.

Explain the purpose of the cache.

.....

.....

.....

..... [2]

(c) The CPU has a component that regulates the number of fetch–decode–execute cycles the CPU can perform in a second.

State the name of this component.

..... [1]

(d) The CPU has a component that carries out all calculations and logical operations.

State the name of this component.

..... [1]

2 A library has a self-checkout system that allows customers to register books that they want to borrow.

The self-checkout system has a central processing unit (CPU).

The CPU has two cores.

(a) State the purpose of a core in the CPU.

.....

..... [1]

(b) The CPU is replaced with one that has four cores.

Explain the effect this has on the performance of the self-checkout system.

.....

.....

.....

..... [2]

(c) The CPU contains registers and buses.

(i) Describe the role of a register in the CPU.

.....

.....

.....

..... [2]

(ii) Identify **one** bus that can be found in the CPU and explain its purpose in the fetch–decode–execute cycle.

Bus .....

Purpose .....

.....

.....

.....

[3]

(d) The self-checkout system allows the user to input their library membership number.

Give **two** appropriate input devices that would allow the user to do this.

1 .....

2 .....

[2]

(e) The self-checkout system uses a monitor to display information about the book.

Users who are blind also need to use the self-checkout system.

Give an appropriate output device that would allow a blind user to be given this information.

..... [1]

(f) The self-checkout system uses two types of primary storage.

Circle **two** types of primary storage that would be used in the system.

compact disk (CD)	digital versatile disk (DVD)
hard disk drive (HDD)	random access memory (RAM)
read only memory (ROM)	universal serial bus (USB) flash memory drive

[2]

(g) The self-checkout system is linked to a stock control system that is updated every time a book is borrowed from the library.

A microprocessor is used in the stock control system to update the stock.

Explain the role of the microprocessor in this system and how it is used to update the stock when a book is borrowed.

.....

.....

.....

.....

.....

..... [3]

2 Phil has a computer that is designed using the Von Neumann model. The computer has a central processing unit (CPU).

(a) One type of component within the CPU is an address bus.

Identify **two** other types of bus and state what each is responsible for transmitting in the CPU.

Bus 1 .....

.....

Bus 2 .....

.....

[4]

(b) The CPU performs a cycle that has three stages. One of these stages is execute.

Identify **one** other stage of the cycle that is performed by the CPU.

..... [1]

(c) Identify the component within the CPU that the accumulator is built into and describe the purpose of the accumulator.

.....

.....

.....

.....

.....

..... [3]

7 The paragraph explains how an instruction is processed by the Central Processing Unit (CPU).

Complete the paragraph using the list of terms. **Not** all terms in the list need to be used.

- address bus
- Arithmetic Logic Unit (ALU)
- calculations
- data bus
- decoded
- execute
- fetched
- interrupt
- Memory Address Register (MAR)
- Memory Data Register (MDR)
- Program Counter (PC)
- protocol
- ROM
- stored

An instruction is ..... from RAM into the CPU, where it is temporarily stored in the ..... . The instruction is then sent along the ..... to the Control Unit (CU) to be ..... . The ..... will then perform any ..... and logic operations that are required to ..... the instruction.

[7]

2 A computer is designed using the Von Neumann model for a computer system.

The computer has a central processing unit (CPU).

(a) Data is fetched from primary storage into the CPU to be processed.

(i) State the name of the primary storage from where data is fetched.

..... [1]

(ii) The CPU performs a cycle to process data. Fetch is the first stage in this cycle.

State the names of the second and third stages in the cycle.

Second stage .....

Third stage .....
[2]

(iii) Identify **two** components within the CPU that are used in the fetch stage of the cycle.

Component 1 .....

Component 2 .....
[2]

6 **Six** statements are given about the role of components in the Central Processing Unit (CPU).

(a) Tick (✓) to show whether each statement applies to the Memory Address Register (MAR), Memory Data Register (MDR) or Program Counter (PC).

Some statements may apply to more than one component.

Statement	MAR (✓)	MDR (✓)	PC (✓)
it is a register in the CPU			
it holds the address of the next instruction to be processed			
it holds the address of the data that is about to be fetched from memory			
it holds the data that has been fetched from memory			
it receives signals from the control unit			
it uses the address bus to send an address to another component			

[6]

(b) Identify the component in the CPU that carries out calculations.

..... [1]

9 Padma opens an application on her computer.

An interrupt is generated to inform the Central Processing Unit (CPU) that the application has been opened.

(a) Give **three** other examples of when an interrupt signal could be generated.

1 .....

2 .....

3 .....

[3]

(b) State what would happen if interrupt signals were **not** used in a computer.

.....

..... [1]

5 In a Von Neumann model for a computer system, a Central Processing Unit (CPU) contains a number of different components.

The table contains the name of a component or a description of their role in the fetch-execute cycle.

Complete the table with the missing component names and descriptions.

Component name	Description
Memory Address Register (MAR)	....
Program Counter (PC)	....
.....	This is a register that is built into the arithmetic logic unit. It temporarily holds the result of a calculation.
.....	This is a register that holds data or an instruction that has been fetched from memory.
Control Unit (CU)	....
.....	This carries addresses around the CPU.

[6]

10 Several components are involved in processing an instruction in a Von Neumann model for a computer system.

Three of these components are the arithmetic logic unit (ALU), control unit (CU) and random access memory (RAM).

(a) Six statements are given about the components.

Tick (✓) to show if each statement applies to the ALU, CU or the RAM. Some statements may apply to more than one component.

Statement	ALU (✓)	CU (✓)	RAM (✓)
stores data and instructions before they enter the central processing unit (CPU)			
contains a register called the accumulator			
manages the transmission of data and instructions to the correct components			
contained within the CPU			
uses the data bus to send data into or out of the CPU			
carries out calculations on data			

[6]

(b) The accumulator is a register that is part of the Von Neumann model.

Give **two** other registers that are part of the Von Neumann model.

1 .....

2 .....

[2]

3.1 Hardware – Computer Architecture
QUESTIONS

8 The Von Neumann model, for a computer system, uses the stored program concept.

(a) Describe what is meant by the stored program concept.

.....

.....

.....

..... [2]

(b) The fetch-execute cycle of a Von Neumann model, for a computer system, uses registers and buses.

(i) Describe the role of the Program Counter.

.....

.....

.....

..... [2]

(ii) Describe the role of the Control Bus.

.....

.....

.....

..... [2]

(c) Computers based on the Von Neumann model, for a computer system, use interrupts.

Explain why interrupts are needed.

.....

.....

.....

..... [2]